

Claims

Sub. A1

1 An apparatus for removing at least one predetermined component from a solution, including:

5 means for holding the solution, having a first inlet and a first outlet;

a reverse osmosis unit having a second inlet coupled to said first outlet and further having a second outlet and a third outlet;

10 means for driving the solution through said reverse osmosis unit for producing a retentate at said second outlet and a raw permeate at said third outlet;

15 a treatment column having a fourth outlet and having a third inlet coupled to said third outlet for conveying the solution therethrough for producing a purified permeate, with at least a portion of the predetermined component removed, at said fourth outlet;

means connected to said fourth outlet and to said third outlet for combining the entire purified permeate with the retentate to produce a treated solution.

20 2. The apparatus of claim 1, wherein said treatment column is an anion exchange column.

3. The apparatus of claim 1, wherein said treatment column is a distillation column.

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4. The apparatus of claim 1, further including means for passing the treated solution again through the apparatus.

5 5. The apparatus of claim 1, wherein:
the at least one predetermined component includes acetic acid;
said reverse osmosis unit includes a membrane configured for
passing at least acetic acid in said raw permeate; and
said treatment column is an anion exchange column for removing
10 acetic acid from the raw permeate.

6. The apparatus of claim 5, wherein:
the at least one predetermined component also includes ethyl
acetate;

15 said membrane is configured for also passing ethyl acetate in said
raw permeate; and

said treatment column includes means for base hydrolyzing the
ethyl acetate for removing it from the raw permeate.

20 7. The apparatus of claim 6, wherein the base hydrolyzing means
comprises ^{means for defining} a region of high pH in said treatment column.

8. The apparatus of claim 1, wherein:

said reverse osmosis unit includes a membrane for passing at least the predetermined component in said raw permeate; and

5 said treatment column is a distillation column for removing at least some of the predetermined component from the raw permeate.

9. The apparatus of claim 8, wherein:

Insert B1
said ~~predetermined component includes~~ acetaldehyde; and
B1
said purified permeate comprises the distillation residue from the
10 distillation column.

10. The apparatus of claim 8, wherein:

Insert B2
said ~~predetermined component includes~~ an alcohol; and
B2
said purified permeate comprises the distillation residue from the
15 distillation column.

11. The apparatus of claim 8, wherein:

Insert B3
said ~~predetermined component includes~~ an alcohol; and
B3
said purified permeate comprises the distillate from the distillation
20 column.

12. A method for treatment of a solution to remove at least one predetermined component, including the steps of:

(1) processing the solution by reverse osmosis for producing a retentate and a raw permeate, with the raw permeate containing the predetermined component;

(2) treating the raw permeate by passing it through an anion exchange column for removing at least a portion of the predetermined component and for producing a purified permeate; and

(3) combining the retentate with the purified permeate for producing a treated solution.

13. The method of claim 12, wherein the predetermined component includes acetic acid.

14. The method of claim 12, wherein:

the predetermined component includes ethyl acetate; and
step 2 includes the step of base hydrolyzing the ethyl acetate.

15. The method of claim 12, wherein:

the at least one predetermined component includes acetic acid; and
step 1 is carried out such that acetic acid is at least partially removed from the retentate and is passed with the raw permeate.

16. The method of claim 12, wherein:

the at least one predetermined component includes ethyl acetate;
step 1 is carried out such that ethyl acetate is at least partially
removed from the retentate and is passed with the raw permeate.

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17. The method of claim 12, further including, after step 1 and before
step 2, the step of:

passing the raw permeate through a low-energy distillation
column for selectively removing at least one relatively volatile
component, thereby producing a distilled raw permeate; and

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carrying out step 2 on said distilled raw permeate, for producing the
purified permeate and the treated solution with a substantial portion of
said relatively volatile component removed.

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18. The method of claim 17, wherein said relatively volatile
component is at least one of carbon dioxide, H_2S , ethyl mercaptan and
dimethyl sulfide.

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19. A method for treatment of a solution to remove at least one
predetermined component, including the steps of:

(1) processing the solution by reverse osmosis for producing a
retentate and a raw permeate, with the raw permeate containing the
predetermined component;

(2) treating the raw permeate for removing at least a portion of the predetermined component and for producing a purified permeate; and

(3) combining the retentate with the purified permeate for producing a treated solution;

5 wherein:

said at least one predetermined component includes acetaldehyde;

step 2 comprises passing the raw permeate through a low-energy distillation column for selectively removing said acetaldehyde; and

10 the purified permeate comprises the distillate from the distillation column.

20. The method of claim 19, wherein:

step 1 is carried out such that the acetaldehyde is substantially removed from the retentate and is passed with the permeate.

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21. A method for treatment of a solution to remove at least one predetermined component, including the steps of:

20 (1) processing the solution by reverse osmosis for producing a retentate and a raw permeate, with the raw permeate containing the predetermined component;

(2) treating the raw permeate by passing it through a distillation column for producing a first portion higher in alcohol and a second portion lower in alcohol; and

(3) combining the retentate with one of said first and second portions for producing a treated solution.

22. The method of claim 21, wherein step 3 includes combining the retentate with said second portion for producing a low-alcohol treated solution.

23. The method of claim 21, wherein step 3 includes combining the retentate with said first portion for producing a high-alcohol treated solution.

24. The method of claim 12, further including the step of:

(4) carrying out steps 1, 2 and 3 on the treated solution, for removing more of the predetermined component from the solution.

25. The method of claim 12, wherein step 1 includes filtering said solution through a reverse osmosis membrane selected for passing acetic acid and ethyl acetate and retaining substantially all malic acid and tartaric acid.